Triangulation of the Phoenix 5-Object Formation

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Overview

On 20 December 2024 at about 10pm, a fleet of 5 aerial objects believed to be drones was photographed hovering over facilities in an industrial area of Phoenix, AZ, including a major United States Postal Service (USPS) facility.

Technical analysis of the photographs (details presented below) indicated they landed within 1 block of that facility. There was concern that the drones were not part of local business operations, but were possibly of nefarious origin.

A number of other sightings of the 5-object formation over Phoenix were also documented on various social media sites (samples shown at the end of this article) and people wondered what they were.

More than two months later, on 3 March 2025 – when this armchair UFO chaser ascertained a confined location for the suspicious drone activity – a bulk email was sent to the affected businesses informing them of the incident. It was hoped that security video of the drone landings might yet emerge.

Since many weeks had passed since the time of the sightings, the incident became merely a "cold case" of little urgency to the relevant authorities. However, on 6 March 2025 a proposal was sent to the Federal Aviation Authority (FAA) requesting that sophisticated tracking and reporting resources be developed for a more timely and coordinated response in future by concerned parties.

Presented below are four Sections:

1) Timeline and 3 key photographs taken from a chase car
2) Initial analysis of the key photographs
3) Triangulation and determination of object altitude and map position
4) Other photographs of the aerial objects.

Timeline and Key Photographs

2024 December 20-24	Multiple photographs were posted on various social media of 5 aerial objects over Phoenix, AZ, and neighbouring towns
2024 December 29 to 2025 January 18	Many of the photographs and videos posted on social media sites were downloaded for analysis
2025 January 28	Interim report of three discoveries: a) the deep blue sunset afterglow in some images indicated a southwest view (https://old.reddit.com/r/UFOs/comments/1hjlft0/uap_over_phoenix/), b) a radar tracking image indicated the flightpath (and hence map location, https://imgur.com/a/hrHIqFA) of an aircraft seen in one TikTok video, c) an on-line post indicated the 5-object formation was moving or drifting (https://imgur.com/a/phoenix-az-december-20-2024-hRIIZfC)
2024 February 18	The map location of one key photo was discovered, taken from the passenger window of a northbound chase car on N 51st Avenue at W Buckeye Road
2024 February 20+22	The map location of a second key photo was discovered. However, classic

	triangulation failed due to non-intersecting sight lines. Possible reasons for this were: a) the objects were moving faster than the chase car, b) the objects were moving towards the path of the chase car (considered more likely)
2024 March 2	Once a 3-dimensional triangulation method was developed, the map location of the third key photo was discovered
2024 March 3	After the probable landing site of the drones was identified, a bulk email was sent to the affected local businesses offering image analysis services
2024 March 6	A report of the incident and a drone tracking proposal was sent to the FAA

Fig. 1a Chase car photo #1 from N 51st Avenue just north of W Lower Buckeye Road showing the 5 aerial objects in the distance and an aircraft on the flightpath to Phoenix Sky Harbor airport (https://imgur.com/a/phoenix-orbs-12-20-24-mbiYlnf).

Fig. 1b Google street view (June 2024) of a Truck Driving School parking lot and a pair of roadside utility enclosures along N 51st Avenue just north of W Lower Buckeye Road.

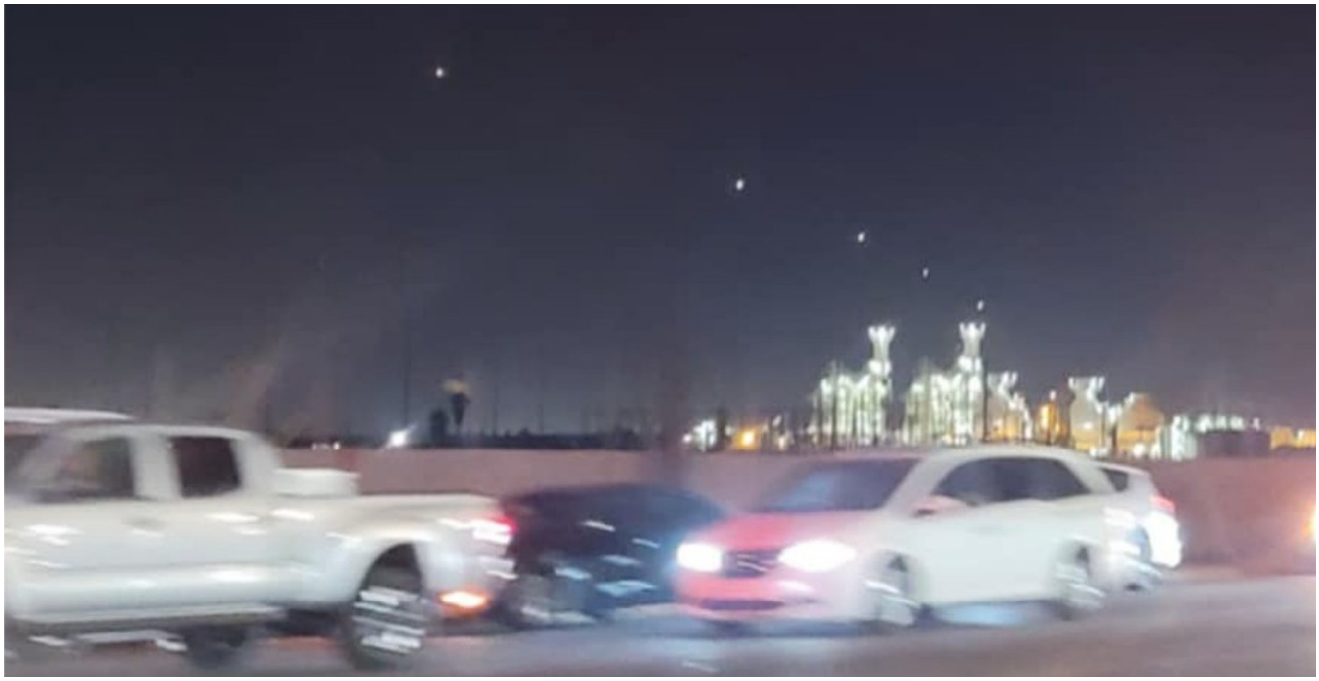


Fig. 2a Chase car photo #2 from the intersection of N 51st Avenue and W Buckeye Road showing the 5 aerial objects and a well-lit industrial facility (https://imgur.com/a/phoenix-orbs-12-20-24-mbiYlnf).

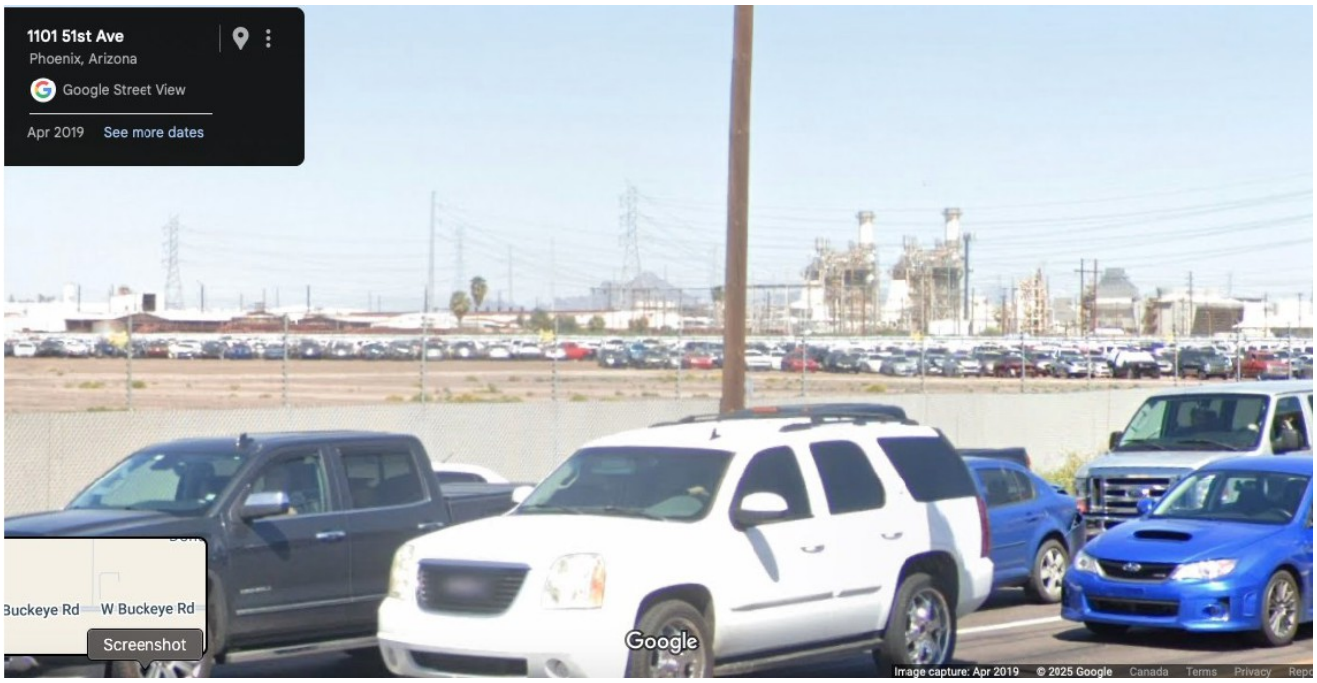


Fig. 2b Google street view (April 2019) at N 51st Avenue and W Buckeye Road, near the West Phoenix Power Plant.

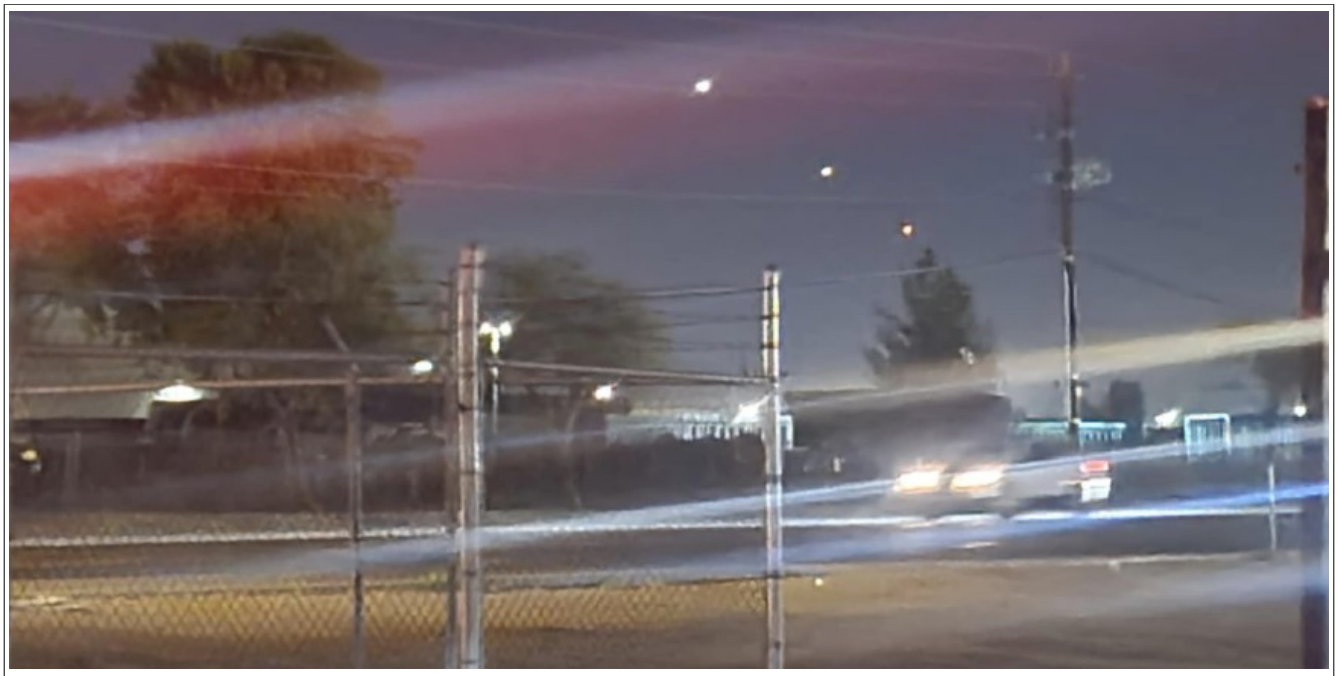


Fig. 3a Chase car photo #3 from the intersection of N 51st Avenue and W Van Buren Street showing 3 of the 5 aerial objects (https://imgur.com/a/phoenix-orbs-12-20-24-mbiYlnf). The red glow to the left of the frame indicates the chase car stopped at a set of traffic signals.

Fig. 3b Google street view (February 2023) at the intersection of N 51st Avenue and W Van Buren Street, Phoenix AZ.

Initial Analysis

1) Each of the key photographs from the chase car, Figs 1-3, was overlaid with vertical and horizontal reference lines. The aerial objects were overlaid with black lines and reference landmarks were overlaid with red lines, Figs 4a-6a.

2) The horizontal and vertical distances of each line from the edges of the photograph was tabulated (in pixels, or centimetres).
3) Similarly, the same landmarks seen in the corresponding Google satellite images were connected by red sight lines to the known map location of the chase car, Figs 4b-6b. These provided compass directions for the equivalent vertical red lines overlaid onto the photographs.
4) Using spreadsheet software, the horizontal distances of the red lines on the photographs were correlated with the map angles.
5) The correlations (linear regression equations) were then used to calculate the compass direction of each object sight line (black line) which was then overlaid onto the map.
6) The same equations were used to calculate the vertical angles (above the horizon) of the objects seen in the photograph. The horizon was taken as a horizontal line drawn through the window of another car seen in the photograph, which was considered to be at the same elevation as the chase car photographer.
7) The angles (horizontal and vertical) were used in the final analysis to determine object altitude and map distance from the camera, Table 1.

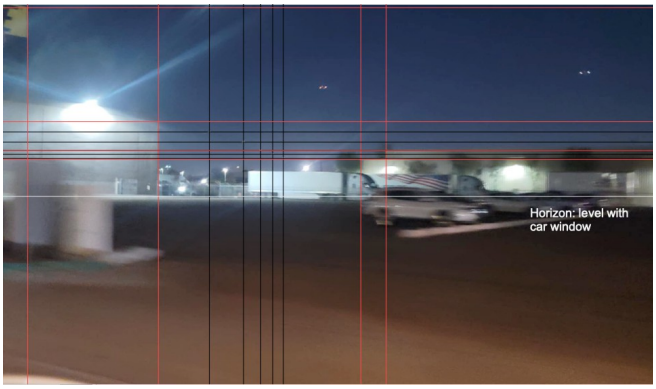


Fig. 4a Photo #1 with black location lines for the 5 objects and red for landmarks.

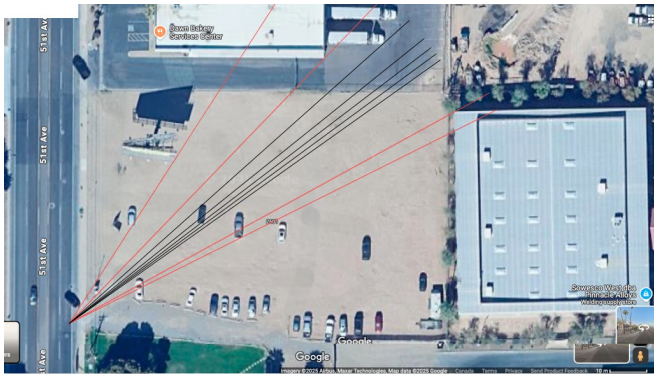


Fig. 4b Google satellite image showing sight lines corresponding to Fig. 4a.

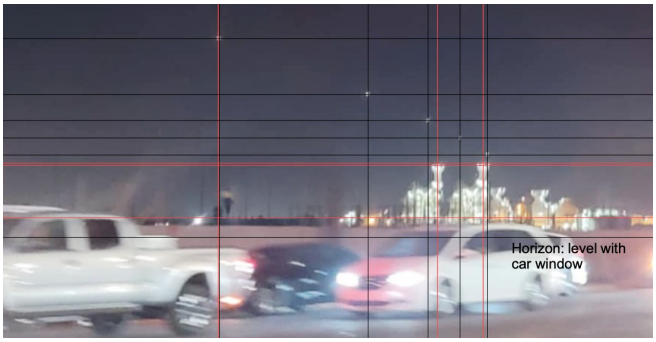


Fig. 5a Photo #2 with black location lines for the 5 objects and red for landmarks.

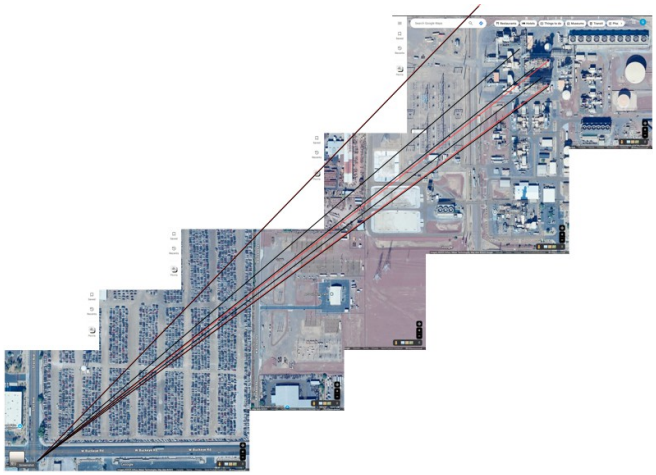


Fig. 5b Google satellite image showing sight lines corresponding to Fig. 5a.

Fig. 6a Photo #3 with black location lines for 3 objects still aloft and red for landmarks.

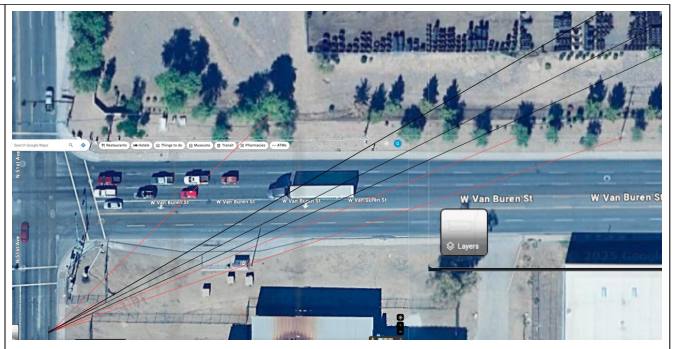


Fig. 6b Google satellite image showing sight lines corresponding to Fig. 6a.

Object (L-R)	Horizontal Angle θ (CCW from East)			Vertical Angle φ (Horizon = 0 degrees)			Difference $\Delta L_{12}=a_{12}\sin\theta_{avg}$		Distance L_1		Distance $L_2=h/\tan\varphi_2$		Distance $L_3=h/\tan\varphi_3$		Altitude $h=L_1\tan\varphi_1$ (object #1)	
	Photo #1	Photo #2	Photo #3	Photo #1	Photo #2	Photo #3	miles	km	miles	km	miles	km	miles	km	ft	m
#1	41.71°	45.91°	30.11°	5.47°	7.11°	10.24°	0.61	0.98	2.62	4.22	2.01	3.24	1.39	2.24	1326	404
#2	38.77°	40.57°	26.69°	4.61°	5.10°	7.85°	0.56	0.90	3.11	5.01	2.81	4.53	1.82	2.93	1326	404
#3	37.32°	38.42°	24.46°	3.90°	4.18°	6.24°	0.54	0.87	3.68	5.93	3.44	5.53	2.30	3.70	1326	404
#4	36.31°	37.27°	-	3.60°	3.56°	-	0.53	0.85	3.99	6.42	4.04	6.50	-	-	1326	404
#5	35.39°	36.28°	-	3.23°	2.94°	-	0.52	0.83	4.45	7.15	4.89	7.87	-	-	1326	404

Table 1 Angular location data from the three identified photos and calculated distances of the 5-object formation (a_{12} = 0.88 miles, a_{23} = 0.99 miles, $\theta_{avg} = (\theta_1+\theta_2)/2$, altitude h is for object #1, camera distance L_1 is Eqn [5] for object #1 and $L_1 = h/\tan\varphi_1$ for objects #2-#5).

Triangulation in 3-Dimensions

While classic triangulation is possible using data from photos #2 and #3, this method will be in error due to motion of the objects. It is necessary to use both the horizontal and the vertical angle data from the three photographs to arrive at the best estimate for the altitude and map position of each object, Figs 7 and 8. It is also necessary to compare the object speed with that of the chase car.

The chase car took roughly 90 seconds to travel 0.88 miles (1.42 km) northbound on N 51st Avenue between photos #1 and #2. It took another 100 seconds or so to travel 0.99 miles (1.59 km) further northbound between photos #2 and #3. Meanwhile, the objects appear to have arrived at their destination and two of them had already disappeared, presumably descending to land.

For the purposes of this analysis, the following assumptions were made:

1) the objects were all flying initially at the same altitude h
2) the sight lines for photos #1 and #2 were essentially parallel
3) the object speed was the same as, or less than, the chase car - about 35 mph (100 seconds/mile)
4) during the time between photos #2 and #3, the objects slowed down and reduced altitude.

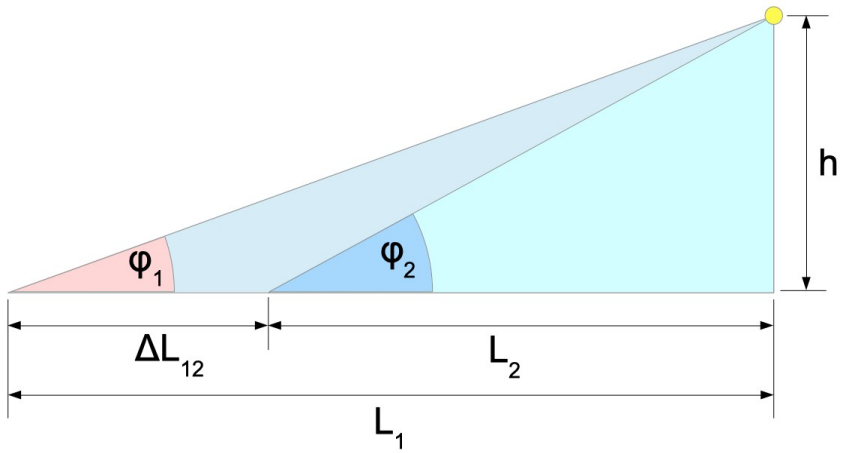


Fig. 7 Vertical triangulation showing relationships between object distances from the camera L_1, L_2, ΔL_{12}, altitude h and known vertical angles φ_1 and φ_2.

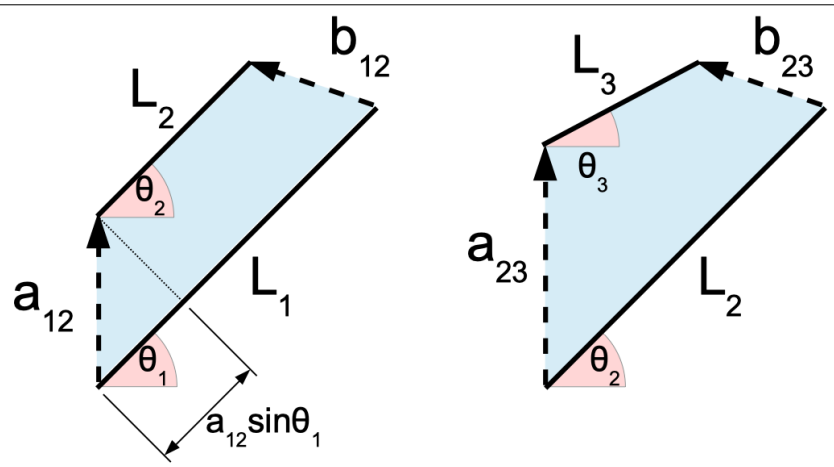


Fig. 8 Horizontal triangulation showing relationships between distances from the camera L_1, L_2, L_3, the known chase car travel distances a_{12}, a_{23}, the assumed object travel distances b_{12}, b_{23} between locations and the known horizontal angles θ_1, θ_2, θ_3. The lefthand figure corresponds to data from photos #1 and #2 (parallel sight lines, $\theta_1 \approx \theta_2$); the righthand figure to photos #2 and #3 (intersecting sight lines).

Since the first two photograph locations were a known distance apart a_{12} along 51st Avenue in Phoenix, and assuming each object stayed close to the same altitude h for the two photographs, from Fig. 7 we have:

$$h = L_1\tan(\varphi_1) = L_2\tan(\varphi_2) \qquad [1]$$

and

$$L_2 = L_1 - \Delta L_{12} \qquad [2]$$

where φ_1 and φ_2 are the known vertical angles of the object above the horizon in photos #1 and #2, respectively. From Fig. 8, the assumption of near-equal speed of the objects with the chase car gives:

$$a_{12} \geq b_{12} \geq a_{12}\cos\theta_{avg} \qquad [3]$$

and

$$\Delta L_{12} \approx a_{12}\sin\theta_{avg} \qquad [4]$$

where $b_{12} = a_{12}\cos\theta_{avg}$ corresponds to the minimum possible object speed for the known horizontal angles of view θ. Since the sight lines are not exactly parallel, the average angle is taken as $\theta_{avg} = (\theta_1+\theta_2)/2$. The inequality for Eqn [3] leads to a limited range for directions of travel of the objects. Substituting Eqn [2] into Eqn [1] and solving, the map distance to the object L_1 becomes:

$$L_1\,[\tan(\varphi_1) - \tan(\varphi_2)] = -\Delta L_{12}\tan(\varphi_2)$$
$$L_1 = \Delta L_{12}\tan(\varphi_2)/[\tan(\varphi_2) - \tan(\varphi_1)] \qquad [5]$$

To minimize measurement errors from the photographs, the data for object #1 was used for the calculations: a_{12} = 0.88 miles (1.42 km), θ_{avg} = 43.81°, ΔL_{12} = 0.61 miles (0.98 km), φ_1 = 5.47°, φ_2 = 7.11°, L_1 = 3.24 miles (5.21 km), L_2 = 2.36 miles (3.80 km) and h = 1326 ft (404 m).

The westward direction of vector b_{12} was chosen because $\varphi_2 > \varphi_1$, meaning the chase car had moved closer to the objects and so they appeared higher in the sky. The distance L_3 was found by extending Eqn [1] and rearranging:

$$L_3 = h/\tan(\varphi_3) \qquad [6]$$

The range of travel directions for object #1 is indicated by a light blue segment in Fig. 9 with respect to a circle around the object location in the first photo. By extending straight lines from there, the "equal speed" scenario $b_{12} = a_{12}$ points directly at a USPS facility, Fig. 10. If object #1 followed that line (indicated by multiple yellow circles), the altitude h would have been reduced to 650 ft (200 m) and distance from the camera L_3 reduced to 0.7 miles (1.13 km) when photograph #3 was taken.

Table 1 presents the results for the altitudes and sight line (map) distances of each object. From the data in photos #1 and #2, the general location of photo #3 was found. The last observed position of object #1 was estimated as 650 ft (200 m) from a United States Postal Service (USPS) facility and 400 ft (120 m) from the Freeport Logistics facility, suggesting that drone delivery may have been taking place.

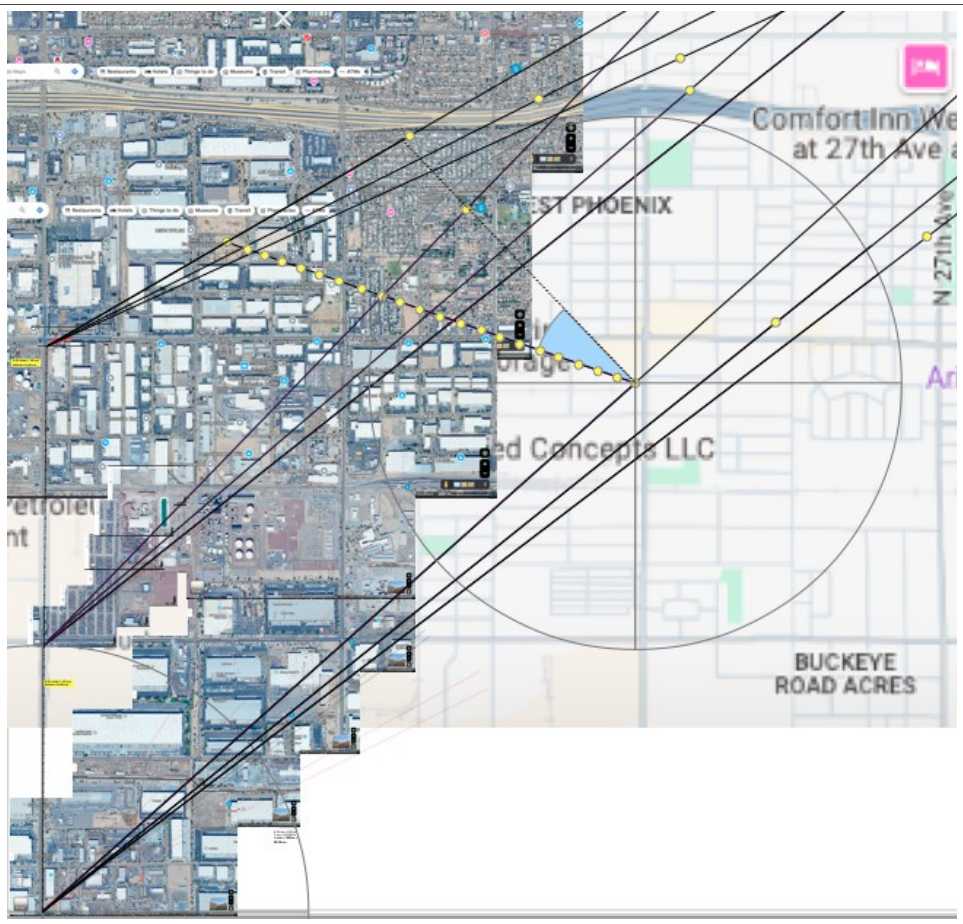


Fig. 9 Map showing the 3 photo locations along N 51st Avenue and the estimated object movement.

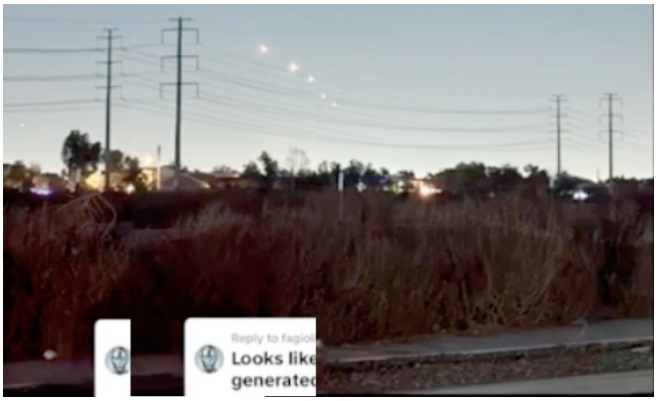
Fig. 10 Closeup of Fig. 9 showing object movement towards a landing near the USPS facility.

Other Photographs

Presented below are samples of on-line posts, including videos, showing the Phoenix 5-object formation of 20 December, 2024, and similar sightings soon afterwards. At the time of writing, precise locations have not been identified. A southwest view is probable for images showing the deep blue sunset afterglow, which also roughly indicates the time of observation (sunset in Phoenix was 5:24 pm MST on 20 December 2024).

(https://www.threads.net/@ufovideostk/post/DD3cQEuNXxF).

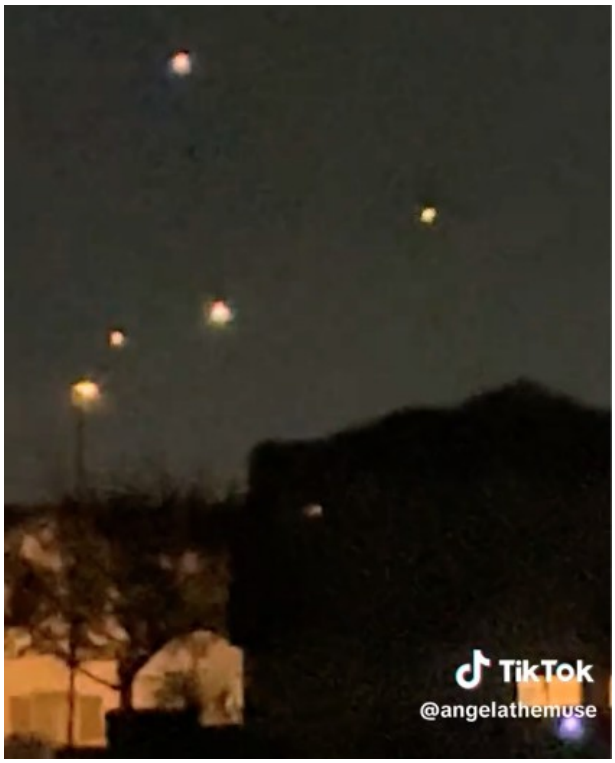
View towards the SW Phoenix sunset afterglow.



View from rural Phoenix 6:14pm MST, 20 Dec. (https://www.reddit.com/r/UFOs/comments/1hjlft0/uap_over_phoenix/ and https://www.tiktok.com/@lasamuel.hobson/video/7456224914450681130).

View from Santan, AZ, 24 December, 2024 (https://www.reddit.com/r/aliens/comments/1hmcg0l/orbs_in_formation_over_arizona_1224/).

View from Gilbert, AZ, 27 December 2024 (https://www.tiktok.com/@angelathemuse/video/7453603203351989550).



View from Gilbert, AZ, 2 January 2025 (https://www.tiktok.com/@angelathemuse/video/7455785697299959082).